DOCUMENT RESUME

ED 428 671 IR 019 332

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TITLE Teaching Effectively with Electronic Databases: Paradigms Suggested by Interactive Changes in Teachers' Mental Models.
PUB DATE 1998-06-00
NOTE 7p.; In: ED-MEDIA/ED-TELECOM 98 World Conference on Educational Multimedia and Hypermedia & World Conference on Educational Telecommunications. Proceedings (10th, Freiburg, Germany, June 20-25, 1998); see IR 019 307.
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Structures; *Computer Assisted Instruction; Databases; Educational Technology; Elementary Secondary Education; Foreign Countries; *Information Retrieval; Interaction; Man Machine Systems; Media Specialists; Models; Qualitative Research; *Schemata (Cognition); Teacher Attitudes; *Teacher Role; Teacher Student Relationship; Teacning Methods
IDENTIFIERS Australia; Interconnection; *Mental Models; United States

ABSTRACT

This study examined the cause-effect interconnectivity of various mental models utilized by 10 American and Australian teachers and media specialists when involved in one-on-one teaching-learning episodes using electronic resources in the context of researching information for authentic school assignments. The researchers investigated runability (i.e., if and how the teachers' mental models changed during the teaching-learning episodes) in order to build a profile of appropriate mental model elements. Methodologies included pre- and post- interviews, video-taped teaching-learning episodes, process-tracing stimulated recall interviews based on the videotapes, and data analysis with the aid of a qualitative software package. The findings describe where variations existed in the mental models with respect to teachers' perceptions of themselves as teacher and learner with electronic databases, their students, lesson planning, teaching strategies, and goals. Contains 18 references. (DLS)

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ED 428 671

Teaching effectively with electronic databases: Paradigms suggested by interactive changes in teachers' mental models

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Abstract: The paper explores the runability cause-effect patterns of teachers' mental models when involved in one-on-one teaching-learning episodes using electronic resources in the context of authentic school assignments. The findings describe where variations existed in the mental models with respect to the perceptions of themselves as teacher and learner with electronic databases, their students, lesson planning, teaching strategies, and goals.

Introduction

Economic, political, and educational progress depends on strong electronic information literacy skills for global access and effective use of information. Productive teaching of computer-based electronic resources requires teachers to have appropriate mental models or schemas of the characteristics and protocols of these resources and strategies to teach effective access, research, and retrieval skills to meet individual students' needs. One method for constructing an appropriate teacher profile paradigm is to explore those mental models in situ. This involves studying changes to the schemas during and after teaching episodes. It also requires a further step that is usually not taken in mental model computer database studies. The paper demonstrates that formulating a relevant teaching paradigm involves examining the impact of changes in one mental model on another mental model or, indeed, other mental models. It reports the study of the cause-effect interconnectivity of various mental models utilized by ten American and Australian teachers when involved in one-on-one teaching-learning episodes using electronic resources in the context of researching information for authentic school assignments.

Mental models

A mental model is defined as a schema or internal domain-specific representation of an object or event that may be incomplete. Mental models can be conceptualized as tools that allow individuals to understand problem situations and predict outcomes as a consequence of their actions [Johnson-Laird 1983]; [Bliss & Ogborn 1989]; [Renk, Branch & Chang 1993]. In a teaching/learning situation where new information is added to the student's and teacher's knowledge, mental models will consequently be in a state of change. They are continuously processing their current schematas as a "runable" event by attaching new information to them and deleting context-irrelevant information from their mental models. This concept of "runability", or the changing state of mental models, is a core defining characteristic of a mental model; in some sense,

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runability is a processing mechanism itself, a process rather than a product [Jih & Reeves 1992]; [Randell 1993]; [Rogers & Rutherford 1992].

The notion of users' mental models is an accepted concept in the human-computer interaction literature although it is often given different terms such as conceptual models, cognitive models, and component models [Staggers & Norcio 1993]. Even so, the research literature dealing with mental models and usage of electronic databases tends to have a narrow focus. First, it mainly concentrates on the learner or user rather than the teacher or librarian, for example, [Stine & Wildemuth 1992] and [White 1994]. Second, it often attempts to establish whether there was a transition in the user's mental model conceptualization from naive to expert, and proceeds to explain why this did or did not occur [Carmel, Crawford, & Chen 1992]; [Doomen & Leuven 1997]; [Jacobson & Jacobson 1993]; [Moray 1986]. Third, the literature significantly focuses on mental models as product rather than process [Randell 1993]. Indeed, although the literature does not deny, it devotes little attention to the multiplicity of mental models simultaneously held by the participants and thereby ignores how these various mental models interact to impact on runability. Thus this paper does not concentrate on the teachers' beginnings or arrival (ie., comparison of their initial and final mental models) but examines the teachers' dynamic mental model adaptations to a complex changing environment [cf. Carley & Palmquist 1992] and [Randell, 1993].

Research Goals

The researchers investigated runability, that is, if and how the teachers' mental models changed during the teaching-learning episodes in order to build a profile of appropriate mental model elements. Those selected for discussion are mental models of: (a) the electronic data base, (b) the role of the teacher, (b) their lesson goals, and (c) their teaching strategies.

Methodology

The following methodologies were chosen to achieve the research goals:
(a) individualized interviews using structured, open-ended questionnaires at the beginning of each individual's participation. These open-ended questions were grounded in the data from a pilot interview and the work of researchers who had previously investigated mental models.
(b) video-taped teaching-learning episodes. In order to obtain a realistic situation, the teachers were asked to structure the teaching episode so as to replicate their normal practice. Thus, the teaching/learning sessions lasted for however long the teachers maintained the instructional interaction.
(c) individual process-tracing stimulated recall interviews based on the videotaped episode. The methodology adhered to the strict protocol developed in Australia for text and interactive multimedia qualitative studies [Marland, Patching & Putt 1992]; [Putt, Henderson & Patching 1996]. Each teaching episode videotape was replayed to the teachers to stimulate their recall of their thinking during the episode.
(d) two individual post interviews containing a set of open-ended questions. One was conducted immediately after each stimulated recall interview while the final, smaller post-interview was administered to each teacher at the conclusion of all previous data collection sessions.
(e) analysis of the data with the aid of the qualitative software package, [QSR NUD*IST 1997]. First, the teachers' mental models were identified. Second, the extended network of concepts within each of these overarching mental models [Carley & Palmquist 1992] were identified from the data and entered into NUD*IST within the identified coding category nodes. Third, the researchers pulled data from any of the nodes in any combination desired.

Sample

The researchers employed a purposeful sample in the United States of one elementary, one middle school, and four secondary media specialists, each with two student participants. These media specialists, selected by the differences in experience and teaching background, were located in Georgia. The study was replicated in Queensland, Australia, with media specialists chosen by their availability and level as closely replicating the United States media specialists as possible. (In Australia media specialists are designated teacher librarians but the term, "media specialists", will apply to both sets of teachers.) The students were chosen by the classroom teachers at the request of the media specialists and had an authentic assignment that required the use of an electronic database resource. By having the media specialists each teach two students, the researchers could identify any adjustments in the teachers' mental models in response to each student's needs and the teachers' reflections on the first teaching/learning episode.

Findings and Discussion

From triangulation of the data it was possible to construct a "before", "during", and "after" profile of the media specialists' mental models as teachers of electronic databases. This paper is concerned with examining some of these mental models in the "during", runability stage of the profile of the teachers. Hence, the before and after profiles are summaries of the findings that, nevertheless, help provide a contextual overview.

The "Before" Profile

The before profile contained the following sorts of mental models. All media specialists held perceptions that their mental model of the database was satisfactory. Their mental models of the role of teachers contained samples of teacher-as-expert, teacher-as-director-of-events, teacher-as-colearner, and teacher-as-facilitator. Their teaching strategy mental models advocated a hands-on approach with the student in control of the keyboard and mouse. Their mental models of what constituted appropriate planning resulted in the following sorts of preparation: only a couple had one or more practice sessions on the database; none developed pencil-paper lesson plans; most reactivated their schema to massage certain teaching strategies into some sort of mental procedural list; and some relied on their years of experience to allow them to utilize effectively their mental model "on the fly". There was variation in the teachers' mental models of their lesson goals: some saw student procedural understanding as the outcome; a few aimed for a conceptual framework in which were located the procedural steps of access, research, and retrieval; many saw having a tangible outcome - a print-out of a list of references or information - as the appropriate goal. The summary details an incomplete list of the teachers' mental models. It nevertheless provides a conceptualization of the number of mental models that teachers utilize for any teaching-learning episode and the range that occurred within the research sample.

Runability: An Examination of the In-Situ Profile

An examination of the "during" teacher profile stage highlights what impact the cause-effect changes in some mental models had on the runability of other mental models.

Not surprisingly, all the teachers perceived they had an adequate mental model of the electronic database they chose to teach to meet the students' assignment needs. The teaching-learning episodes exposed discrepancies with these perceptions. Analysis revealed there was a range from a superficial working knowledge to robust conceptualisation of their database mental models. Significantly, the same range existed within several individual teachers' mental models of the database, thus exposing a fluctuating understanding of the complexities of the databases. Such inconsistencies in their mental models of the database had repercussions for the teachers' mental models of (a) the role of the teacher and (b) the teaching strategies utilized during the lesson. The following helps clarify this example of mental model runability.

Two media specialists experienced near-replica "technical nightmares", that is, breakdowns in their mental model conceptualization of the database protocols when attempting to establish dial-up access through the Internet to the university and public libraries, respectively. One media specialist's mental model of herself as a teacher of electronic databases was that of co-learner with the student. Putting her mental model into practice, she openly discussed her bewildered lack of success and ensured that the student was co-solver of the teacher's predicament. During the stimulated-recall interview, the teacher stressed that she consciously thought that her teaching strategy demonstrated her mental model of the teacher as co-learner and that it would help the student create a new, or reinforce her existing, mental model of the legitimacy of the teacher as a continuing learner. In contrast, another media specialist's ambiguous mental model permitted her to admit errors while still maintaining the role of director-of-events, thereby overlooking the possibility of inviting her student's involvement in finding solutions. She reported that her overriding consideration during technological "moments of panic and discomfort, because of unfamiliarity with the database," involved a mental model of the role of teacher as expert: "I was concerned a little bit about my own image ... I didn't want to come across as if I didn't know what I was doing." Her mental model involved her normal immediate preference for "abandoning ship" and asking the student to come back later. Time-out would allow her to develop a more consistently robust mental model of the database that, in turn, would reestablish her mental model of herself as teacher-as-expert of electronic databases in both in her own and, ipso facto, the students' eyes.

Most media specialists' mental models of the lesson goal were for the students to acquire procedural understanding, that is, be able to repeat the procedures for access to the database and location of appropriate content. This mental model dovetailed smoothly with the added goal of obtaining the best immediate resources for their students' assignments. Too few of the media specialists helped their students form a mental model or image of the resource itself in its broader dimensions. According to researchers [Borgman 1984] and [Brown, Collins & Duguid 1989], students need to be exposed to the use of a domain's conceptual tools in authentic activity for robust mental model acquisition. Teaching with the goal of obtaining a successful product, such as a list of appropriate resources, has been a traditional approach for resource location and access. The goal has concentrated on imparting a set of procedures for the student to follow. Thus, its transferability to teaching with electronic resources, as demonstrated by some of the media specialists, is problematic. When confronted with electronic resources users do not have the opportunity to see everything that the database contains as they can with print resources. They are confronted with one computer screen with one page of information. A mental model of the information and all the various linkages to the information is necessary before students can create their own mental models of the procedures they need to follow to retrieve information successfully.

All the media specialists held mental models of how to teach database access, research, and retrieval that reflected an important tenet in Piaget's and Bruner's learning theories, that of direct experience. Students were to have hands-on experience with the computers. Some teachers shared this mental model with their students thereby making the rationale visible in terms of student learning outcomes: "... you will remember more if you do it yourself instead of my just telling you how to do it." Most initially had a mental model of sitting beside the student who had control of the keyboard; some did not succeed because their mental model in operation was affected by their mental model of the student's abi!ity: "The temptation to touch the keyboard was too much given the student's hesitancy and I sort of jumped in." Others encompassed a show-and-tell-then-copy-me strategy whereby the students took control during the latter half of the lesson in order to demonstrate their ability to replicate the teacher's procedures. Although all allowed hands-on, many teachers used directive statements or questions; only a few adopted a questioning technique that involved procedures, predictions, and consequences of the database's navigational and/or hypermedia features.

An examination of the interconnectivity of two of the teachers' mental models with respect to their lesson goals, teaching strategies, and role of the teacher helps clarify these points. One media specialist concentrated on the student's acquisition of procedural skills while the other saw conceptual as well as procedural understanding as the important learning outcome. Both used questioning strategies. A simple tally of the number and types of questions from the transcriptions of the taped video lessons reveals significant differences. The former teacher asked 79 questions of which 30 (38%) required a yes/no answer and a further 34 (43%) were also of the closure type needing the correct answer. The latter teacher asked 54 questions of

which 11 (20%) required yes/no answers with a further seven (13%) being closed-answer questions. For the former teacher that left a mere 15 (19%) questions that demanded higher level thinking from the student; for the latter, a substantial 36 (67%). Both sought answers requiring deduction, prediction, and interpretation; however, the teacher whose goal was for the learner to be able to conceptualize the relevance of the hypermedia and navigational features of the database also required the student to compare, explain, synthesize, and extrapolate. Neither media specialist experienced conflict among their teaching strategies and lesson goal mental models and their mental models of the role of the teacher. It was no surprise that the data revealed the former teacher's mental model held the teacher-as-director-of-events whilst the latter depicted the teacher-as-facilitator.

Conclusion

The profile of the teachers' mental models at the conclusion of the study revealed that some media specialists made dramatic changes to some of their mental models, for the better, in their perception; others made modifications to counteract weaknesses; and some maintained the status quo. This last group retained a mental model that essentially held that there was one way to teach electronic database skills regardless of the student's age, learning style, level of computer/database expertise, student outcome needs, and, significantly, the database itself. Data suggests that they did not recognize the inappropriateness of these mental models, particularly when teaching the lessons. Data also revealed that the "status quo" group and a few of the other media specialists had no perception that their mental models as carried out in practice did not reflect their "before" mental model. Interestingly, some media specialists did perceive this, and acknowledged this verbally in their first post-stimulated recall interview. However, the mental models evidenced during their second teaching-learning episode did not reflect their earlier statements and belief that they had now, indeed, incorporated the changes to their mental models. Our study suggests that mental models are ingrained during initial experience with print resources and the procedures used to teach access of information in print resources. Transition to electronic resources requires of acceptance of changes in mental models to incorporate consistent robust conceptualization of the hypermedia features of electronic databases.

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